

ON THE NATURE OF THE EFFECT OF THE SUN-SPOT
FREQUENCY ON THE VARIATION OF THE MAG-
NETIC ELEMENTS AT THE CAPE OF GOOD HOPE.

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§ 1. The relationship existing between the Sun-spot Frequency and the variation of the various elements of Terrestrial Magnetism has of late been much discussed. So far, however, no results for the Cape of Good Hope have been published; the following is an account of some of these and of how they have been obtained. The observations upon which this investigation is based are those taken by a detachment of the Royal Artillery during the period 1842-1846, both inclusive, and published by Sabine in a series of volumes entitled "Magnetical and Meteorological Observations," a copy of which is to be found at the Royal Observatory (Cape).

§ 2. *Declination.*

Sabine gives a table of figures representing in Scale Divisions the mean hourly position of the magnet of the Declinometer for the period 1842-1846. Wolf's formula for associating magnetic quantities with Sun-spot Frequency is—

$$\Delta = \Delta' + r\Delta''$$

where r = Sun-spot Frequency.

In applying Wolf's formula to the above observations Δ is taken as the excess of the hourly mean over the monthly mean in minutes of arc (one sc. div. = $\cdot 751'$).

Knowing the daily inequality of the Declination and the various values of r we can determine the most probable values of the

TABLE OF SUN-SPOT FREQUENCIES.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1842	·2	·22	·22	·27	·25	·21	·13	·27	·19	·38	·41	·18
1843	·13	·04	·08	·08	·21	·11	·10	·12	·04	·05	·19	·13
1844	·09	·15	·14	·21	·12	·04	·21	·24	·07	·22	·11	·22
1845	·26	·44	·43	·57	·48	·31	·31	·32	·30	·41	·39	·60
1846	·39	·51	·64	·69	·60	·65	·47	·55	1·07	·56	·60	·66

quantities $\Delta'D$ and $\Delta''D$ for any particular hour by applying the principle of least squares and solving the resultant normal equations.

The results obtained by solving the various equations are given in Tables II. and III. Table I. contains the mean daily inequality for the period considered.

TABLE I.

$\Delta D.$

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon												
+34 min.												
0	·82	·20	·52	·64	·60	·83	1·18	1·99	1·08	1·34	·62	·88
1	1·52	2·02	1·73	1·51	·07	·22	·51	1·04	·06	2·23	1·62	1·79
2	1·91	2·96	2·35	1·39	·41	·25	·26	·19	·39	2·21	1·98	1·74
3	1·33	2·61	1·96	1·04	·50	·25	·45	·65	·53	1·62	1·72	1·21
4	1·01	1·67	1·09	·76	·16	·15	·95	·37	·33	·57	1·19	·76
5	·78	·95	·66	·42	·25	·53	·58	·34	·07	·10	·77	·63
6	·56	·59	·58	·18	·12	·47	·55	·28	·03	·33	·83	·58
7	·78	·90	·71	·36	·06	·53	·66	·14	·16	·63	1·24	·93
8	1·06	·86	·68	·34	·07	·32	·36	·04	·22	·74	1·34	1·16
9	·56	·95	·65	·36	·18	·21	·26	·13	·12	·74	1·34	1·14
10	·98	·91	·55	·33	·20	·21	·06	·03	·2	·72	1·23	1·16
11	·72	·66	·66	·35	·15	·05	·12	·11	·14	·65	1·24	1·16
12	·56	·68	·59	·31	·24	·10	·30	·24	·23	·56	1·13	·97
13	·29	·56	·74	·48	·41	·36	·45	·34	·33	·59	·94	·8
14	·11	·51	·69	·51	·39	·33	·49	·47	·35	·37	·7	·58
15	— ·05	·4	·60	·47	·58	·54	·51	·75	·40	·23	·36	·22
16	— ·36	·28	·53	·61	·68	·51	·50	·83	·40	·16	— ·01	— ·23
17	— ·81	·15	·47	·76	·75	·58	·56	1·03	·57	— ·14	— ·65	— 1·02
18	— 1·49	— ·18	·02	·66	1·18	·96	·82	1·73	1·87	— ·73	— 1·99	— 2·32
19	— 2·36	— 1·82	— 1·58	— ·29	1·50	+1·65	1·64	2·27	1·94	— 2·36	— 3·28	— 3·52
20	— 2·94	— 3·96	— 3·83	— 2·37	— ·22	·94	1·18	1·09	·01	— 3·79	— 4·69	— 3·63
21	— 2·86	— 5·31	— 4·80	— 3·57	— 1·75	— ·54	— ·47	— ·94	— 1·72	— 3·56	— 4·28	— 3·16
22	— 1·98	— 4·31	— 3·62	— 3·22	— 2·47	— 1·35	— 1·47	— 2·33	— 2·75	— 2·38	— 2·21	— 1·64
23	— ·59	— 2·24	— 1·41	— 1·46	— 1·83	— 1·29	— 1·75	— 2·75	— 2·41	— ·57	— ·75	— ·26

TABLE II.

$\Delta'D$

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon +34 min.												
0	.52	.63	.73	1.11	0.6	-1.1	-.83	-2.17	-.62	.59	.48	-.02
1	.94	2.35	1.54	1.43	.33	-.02	-.58	-1.0	-.19	1.21	2.15	.96
2	.26	2.43	1.62	.03	.15	.38	-.25	1.17	.19	1.59	2.41	1.26
3	.58	1.76	1.27	.33	.13	.31	0.	1.17	.25	1.19	2.15	.84
4	1.07	.91	1.0	.33	-.44	-.06	.83	.33	.06	1.16	1.26	.64
5	1.03	.36	.5	-.49	-.61	-.34	-.58	-.67	.25	0	.81	.91
6	.58	.29	.68	-.26	-.48	-.31	-.5	.17	0	.19	.52	.8
7	.55	.69	.34	-.18	-.22	-.50	-1.08	.33	.14	.41	.96	.75
8	.71	.65	.78	.02	-.18	-.18	-.33	-1.32	.33	.56	.74	1.17
9	.81	.75	.73	-.03	-.02	0	-.42	.17	.14	.56	1.11	1.07
10	1.13	.75	.47	.16	.22	.05	-.08	.67	.23	.72	1.0	1.04
11	.68	.65	.66	.21	.18	.18	.08	.67	.22	.66	1.22	1.13
12	.45	.77	.63	.69	.37	.11	.33	.83	.37	.59	.89	.86
13	.19	.71	.71	.61	.44	.31	.75	.83	.34	.56	.78	.52
14	-.07	.91	.78	.72	.54	.45	.83	.83	.34	.44	.52	.37
15	-.39	.33	.43	1.05	1.18	.54	1.0	1.0	.49	.31	.33	-.01
16	-.35	.12	.35	1.0	1.09	.38	.5	1.33	.31	.31	-.03	-.39
17	-.68	-.16	.36	1.28	.88	.54	.42	1.5	.61	-.12	-.59	-1.13
18	-1.06	-.73	-.59	.65	.96	1.02	.33	1.83	1.25	-.62	-1.52	-2.21
19	-1.51	-.77	-1.75	.08	.96	1.69	1.25	2.17	1.59	-1.28	-3.29	-2.96
20	-2.09	-3.89	-4.04	-1.93	-1.7	.82	.58	.5	-.27	-2.62	-3.37	-2.5
21	-2.16	-4.61	-2.87	-2.46	-1.56	-.87	-1.0	-.17	-2.13	-3.19	-5.33	-2.05
22	-2.29	-2.34	-2.93	-1.25	-1.87	-1.76	-1.33	-1.67	-2.37	-1.97	-2.81	-.93
23	-.65	-.68	-2.24	.11	-1.16	-1.59	-1.42	-2.83	-1.94	-.6	-1.59	-.37

TABLE III.

$\Delta''D$.

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon +34 min.												
0	1.36	-1.53	-.54	-1.07	-1.46	.91	-1.75	1.5	-2.81	2.75	.52	3.14
1	3.58	-1.21	.78	.21	-.72	-.81	.33	.17	.94	3.66	-1.92	2.96
2	6.71	2.0	2.5	3.66	+ .74	.45	2.75	-4.0	1.5	2.29	-1.7	1.7
3	3.55	2.44	2.35	1.67	1.0	.5	1.81	-1.9	2.0	1.62	-1.59	1.45
4	-.32	2.68	.33	1.69	1.67	-.36	-4.67	.5	1.81	1.06	-.22	.43
5	-1.19	2.07	.5	2.1	.98	-.59	-.08	.83	-1.25	.41	-.11	-1.13
6	-.19	1.01	-.32	1.02	1.0	-.54	-.08	-1.83	.09	.62	1.04	-.79
7	1.13	.72	.08	1.24	.44	-.08	2.0	.5	.12	.81	1.07	.64
8	1.42	.75	-.31	.79	.65	-.47	-.17	1.0	-.75	.69	2.11	.25
9	.26	.68	-.24	.92	.56	-.83	.92	.17	-.09	.66	.93	.25
10	-.81	.08	.28	.31	-.07	-.83	.08	-3.0	-1.28	.09	.78	.46
11	.13	-.07	-.01	.33	-.15	.54	.17	-2.83	-.56	-.06	.19	.16
12	.45	-.41	-.14	-.89	-.35	-.04	-.05	-2.67	-1.0	-.09	.85	.41
13	.45	-.52	.05	-.31	-.11	-.14	-1.33	-2.5	-.12	.06	.52	.96
14	.81	-1.37	-.27	-.31	-.41	-.14	-1.92	-2.17	.07	-.25	.63	.73
15	1.45	.24	.56	-1.11	-1.69	-.05	-2.67	-2.0	-.54	-.23	.17	.82
16	.13	.52	.61	-.9	-1.48	.41	.25	-2.17	.75	-.62	.06	.52
17	-.68	1.09	.37	-1.26	-.37	.12	.67	-1.83	-.12	-.03	-.33	.3
18	-1.94	1.95	2.02	.01	.57	-.17	2.75	-.5	4.0	-.28	-1.87	.39
19	-4.0	-1.17	.59	-.85	1.46	-.15	1.83	.33	2.37	-3.91	-1.96	-2.04
20	-3.64	-.35	.68	-1.01	-.15	.37	3.25	2.0	1.87	-4.22	-4.81	-4.12
21	-3.06	-1.63	-3.34	-2.61	-.61	1.06	2.67	-3.0	3.0	-1.25	2.96	-3.93
22	1.71	-7.33	-2.48	-4.49	-1.59	1.37	-.42	-2.33	-3.25	-1.31	-2.26	-2.68
23	.19	-5.91	-2.76	-3.61	-1.81	1.01	-1.75	.5	-3.12	.19	3.11	-.41

§3. *Horizontal Intensity.*

In the case of the Horizontal Intensity the figures given by Sabine represent the value of the ratio $\frac{h}{H}$, where h is the value of the Horizontal Intensity taking the lowest hourly mean of that quantity for the month as zero, and H is the monthly mean value of the Horizontal Intensity. Knowing H we can readily obtain the daily inequality of the Horizontal Intensity to which Wolf's formula—

$$\Delta H = \Delta'H + r\Delta''H.$$

is applicable in the same way as in the case of the Declination.

TABLE IV.

$\Delta H.$

UNIT 1γ.

Cape of Good Hope Hour (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon +34 min.												
0	.4	— .1	— .4	— 1.3	2.1	— .1	+ 8.8	7.1	5.6	— 5.0	— 4.0	.7
1	.8	— 1.7	.7	— 1.9	— 1.7	— 1.1	— 1.0	2.0	2.0	1.0	— 1.3	0
2	.5	— 1.5	1.0	— 1.5	— 2.6	— 1.2	— .6	— 2.7	— .8	2.8	.1	— 1.5
3	.9	— .9	1.2	— 2.0	— .9	.3	.9	— 3.7	— 2.5	2.2	.5	— 1.1
4	.3	— .3	1.5	— 1.5	1.4	4.7	3.1	— 2.1	— 3.5	— .4	— 1.2	— .9
5	0	— .5	— .1	— 2.1	.9	3.8	2.4	— 1.2	— 4.5	— 2.7	— 3.5	— 2.2
6	2.0	— 2.7	— 3.5	— 4.9	— .8	1.3	— .4	— 3.3	— 7.3	— 4.7	— 4.6	— 3.3
7	— 4.3	— 4.9	— 5.8	— 5.7	— 2.5	— 1.8	— 2.7	— 6.2	— 7.5	— 5.7	— 8.4	— 7.1
8	— 5.6	— 5.5	— 6.5	— 6.1	— 4.9	— 3.7	— 4.1	— 6.8	— 8.3	— 5.6	— 6.2	— 7.7
9	— 6.2	— 5.0	— 5.2	— 5.9	— 6.1	— 4.9	— 6.4	— 7.2	— 8.4	— 5.3	— 5.0	— 6.1
10	— 5.5	— 3.8	— 5.0	— 4.3	— 5.2	— 4.8	— 6.8	— 6.0	— 6.3	— 4.3	— 4.2	— 5.2
11	— 4.2	— 2.8	— 2.8	— 2.3	— 5.1	— 4.3	— 5.7	— 5.1	— 3.5	— 2.9	— 2.8	— 3.9
12	— 2.3	+ .2	— 1.9	— 5.0	— 3.1	— 4.2	— 4.8	— 3.9	— 2.6	— 1.6	— 1.0	— 3.4
13	— 2.1	.3	.7	1.4	— 2.3	— 3.7	— 3.2	— 2.8	— 1.0	— .6	— 1.0	— 2.9
14	— 1.2	1.8	1.5	1.7	— 2.4	— 3.5	— 1.5	— 2.0	.5	— .5	.2	— 1.7
15	.2	1.6	1.0	3.1	— 2.1	— 2.2	— 1.8	— 1.5	0	+ .5	.1	— 2.2
16	.7	1.6	1.6	1.8	— 1.1	— 1.9	— .6	— .8	.1	+ .4	1.4	— .6
17	3.3	2.0	1.1	2.2	— .8	— 2.0	— .3	— 1.3	— .1	1.6	3.7	2.9
18	6.1	4.5	3.5	3.6	1.6	— .1	1.4	— .3	.3	4.4	8.6	7.4
19	7.9	7.8	7.5	7.4	5.5	3.6	4.6	4.8	5.5	8.1	2.0	10.5
20	8.2	7.2	9.0	8.2	7.9	8.0	8.1	9.9	10.6	7.7	9.8	11.7
21	4.1	4.1	5.0	5.9	9.6	8.8	8.8	12.2	13.4	5.4	5.6	9.2
22	.8	— .2	— .1	3.7	7.6	6.7	7.5	11.6	12.2	1.4	.2	4.6
23	.7	— .2	— 2.5	.5	4.7	2.7	4.9	9.5	7.6	— .5	— 1.5	2.1

TABLE V.

$\Delta'H.$

UNIT 1 γ .

Cape of Good Hope Hour (Astronomical).		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon	+34 min.												
	0	1.0	-4.3	-3.9	-8.8	2.9	-2.7	-1.8	-3.5	5.4	-1.1	1.0	3.2
	1	.6	-4.1	-1.7	-9.0	0	-4.1	-2.7	3.5	3.5	1.3	.9	5.6
	2	1.5	-1.6	.2	-4.3	.9	-2.0	-1.7	.3	1.6	2.2	.7	-2.0
	3	2.9	-1.2	-1.0	-2.6	8.0	-.9	.6	1.9	1.5	2.2	.8	-1.0
	4	2.5	-.3	0	-2.8	2.4	5.3	1.3	-1.5	-4.1	.4	-5.2	1.0
	5	-4.1	-.7	.7	-4.6	.7	3.0	-.1	3.3	-3.7	-6.2	-5.1	-1.4
	6	-6.1	-2.8	-5.0	-6.2	-1.6	1.8	-4.0	-3.0	-7.4	-4.7	-6.7	-1.7
	7	-4.2	-4.7	-5.1	-7.1	2.1	.4	-5.3	-4.7	-8.3	-4.9	-8.2	-6.8
	8	-5.0	-5.0	-2.8	-6.0	6.2	-2.7	-6.3	-1.0	-8.9	-3.4	-8.0	-8.3
	9	-5.5	-3.8	-17.2	-5.7	-8.0	-3.3	-8.5	-4.0	-8.5	-6.9	-6.6	-7.8
	10	5.7	-3.1	-6.7	-5.4	-7.7	-3.3	-9.8	-5.3	-8.9	-4.9	-5.2	-6.4
	11	-2.7	-1.9	-3.9	-1.8	-5.0	-3.3	-5.7	-2.0	-3.2	-2.1	-1.5	-3.4
	12	-2.1	.3	-2.1	.8	-3.8	-4.7	-3.0	-5.0	-4.3	-2.2	-1.0	-3.6
	13	-.9	4.7	1.0	5.7	-2.9	-4.0	-.7	+3.0	-5.2	.6	.4	-3.0
	14	.1	1.3	2.5	7.0	-3.0	-3.3	2.2	.5	-.5	-.4	.8	-1.3
	15	.4	2.7	2.4	6.4	-1.0	-.9	1.6	.6	.2	1.5	-8.0	-2.3
	16	-1.0	2.5	2.5	4.9	-.3	-1.5	2.8	-1.3	.2	1.2	1.6	.8
	17	3.5	3.1	.8	9.5	-.3	-2.2	4.8	-1.0	.4	2.5	2.5	.9
	18	5.4	5.1	5.3	8.9	3.2	+5	4.5	-1.2	.6	4.0	8.6	4.7
	19	6.2	9.1	8.9	9.5	5.4	4.7	7.4	8.0	5.7	7.5	10.8	6.7
	20	4.6	7.2	4.3	9.3	5.6	7.8	10.0	13.3	10.3	10.2	9.4	9.1
	21	1.1	2.1	6.7	7.4	8.3	10.0	9.3	2.0	13.1	5.0	5.8	8.1
	22	-.5	-1.2	-.4	2.8	6.7	6.3	7.5	2.3	9.4	.2	1.5	5.3
	23	-1.0	-1.1	-3.1	-4.0	4.9	.2	2.5	-1.5	4.5	-3.0	2.6	5.0

TABLE VI.

$\Delta''H.$

UNIT 1 γ .

Cape of Good Hope Hour (Astronomical).		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon	+34 min.												
	0	-4.0	19.7	15.7	17.4	-2.9	15.0	14.2	41.7	1.4	2.5	-1.4	-9.0
	1	2.0	10.9	11.7	16.7	-7.1	17.3	9.2	-6.7	-10.0	-1.1	-7.8	-5.0
	2	-6.0	.9	3.2	6.9	-13.3	4.0	5.8	-9.0	-16.2	1.7	-2.0	1.4
	3	-12.0	1.6	10.0	1.5	-11.2	7.5	1.7	-22.2	-25.8	0	-1.4	.4
	4	-7.4	.1	7.1	2.8	-3.8	.4	10.0	-2.0	-15.7	0	.2	-4.9
	5	24.0	1.3	-4.3	5.9	.9	.5	13.3	-19.0	-5.4	14.0	5.6	-2.6
	6	-25.0	.7	7.3	3.1	2.9	-.3	15.0	-.8	+1.2	.4	7.9	-5.7
	7	0	-.7	.7	3.2	-.9	-8.3	14.4	-5.7	6.0	-2.8	6.9	-.9
	8	-3.0	-1.9	2.1	-.1	5.4	-6.0	12.5	16.0	4.1	-8.0	6.6	1.9
	9	-3.0	-5.7	-3.5	-.5	.8	-8.7	12.7	-12.3	.6	6.5	5.9	5.8
	10	1.0	-2.3	8.5	2.5	9.1	-8.7	16.7	-1.7	16.6	2.5	3.9	4.3
	11	8.4	-4.4	4.5	-1.1	0	-6.7	1.2	-12.0	-2.1	-2.8	-3.7	-1.6
	12	-1.0	-.9	1.0	-5.3	2.9	3.3	-10.0	4.0	11.5	2.4	0	.9
	13	-6.9	-0.3	-1.7	-10.0	1.9	.2	-13.3	-12.5	28.0	-.2	-4.9	.3
	14	-7.4	-23.1	-5.3	-12.4	2.5	-1.3	-20.0	-11.7	7.0	.2	-2.2	-1.5
	15	-1.4	-5.3	-6.4	-7.7	-3.8	-.8	-18.3	-8.3	-.7	-3.8	7.7	.1
	16	-9.6	-3.5	-4.3	-7.3	-2.7	-.3	-18.3	2.5	-.7	-3.1	-.6	-4.8
	17	-.8	-5.6	1.8	-7.9	-2.1	1.5	-27.0	-.8	-3.5	-3.4	4.2	7.1
	18	3.0	-5.9	-8.2	-12.3	-6.3	-2.3	-16.0	4.0	-2.0	1.5	.2	9.5
	19	14.5	-6.2	-6.1	-4.9	0	-4.7	-15.6	-14.0	-2.1	2.0	4.4	13.6
	20	20.3	0	-23.2	-2.5	8.8	0	-10.0	-17.0	1.7	-9.5	1.1	9.3
	21	17.0	9.1	-6.6	-3.4	4.2	-5.7	-3.3	40.0	1.9	1.3	-.9	4.1
	22	7.0	4.7	1.2	2.0	3.7	2.7	0	35.0	19.0	4.3	-4.7	-2.8
	23	9.6	-4.0	6.5	10.7	-.9	15.3	6.7	45.0	22.5	9.5	14.9	-10.0

§4. *Easterly and Northerly Components.*

By the differentiation of the ordinary trigonometrical relation between Easterly Component, Horizontal Intensity, and Declination, and between Northerly Component, Horizontal Intensity, and Declination, we have—

$$\begin{aligned} \Delta Y &= \Delta H \sin D + H \cos D \Delta D \\ \Delta X &= \Delta H \cos D - H \sin D \Delta D. \end{aligned}$$

A monthly mean value of D can be calculated from the records published by Beattie and Morrison in the TRANSACTIONS OF THE SOUTH AFRICAN PHILOSOPHICAL SOCIETY. We have then sufficient data for obtaining the daily inequality of the Easterly and the Northerly Components (Tables VII. and X.).

Again we have—

$$\begin{aligned} \Delta' Y &= \Delta' H \sin D + H \cos D \Delta' D \\ \Delta' X &= \Delta' H \cos D - H \sin D \Delta' D \end{aligned}$$

with two equations of a similar nature for $\Delta'' Y$ and $\Delta'' X$.

TABLE VII.

ΔY .

UNIT 1γ .

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon + 34 min.												
0	4.4	1.0	2.4	2.7	2.1	4.3	5.7	6.9	2.9	4.5	1.2	4.9
1	8.3	9.7	9.3	7.0	4	1.6	3.2	4.4	2	12.1	7.8	9.3
2	10.1	14.7	12.7	6.5	8	7	1.1	3	1.6	12.9	10.3	8.3
3	7.2	13.2	10.8	4.7	2.2	1.4	2.7	1.6	1.6	9.5	9.1	5.8
4	5.8	8.5	6.4	3.2	.1	1.4	3.4	.9	0	1.0	5.6	3.6
5	4.1	4.7	3.4	1.2	.9	.9	1.8	2.4	1.8	.8	2.3	2.2
6	1.9	1.8	1.3	1.5	1.0	1.8	3.1	3.1	3.4	.6	2.0	1.4
7	2.0	2.3	.1	.9	1.5	3.7	4.7	3.7	2.9	.5	2.3	1.3
8	3.0	1.8	.3	1.1	2.8	3.5	3.9	3.3	3.0	1.1	4.0	2.2
9	1.5	2.5	.9	1.0	2.1	3.6	4.5	2.8	3.5	1.2	4.5	2.9
10	2.5	2.8	.5	.3	1.0	3.6	3.6	2.8	1.7	1.5	4.3	3.5
11	1.6	2.0	2.0	.7	1.7	2.0	2.2	1.9	1.0	2.0	5.2	4.1
12	1.8	3.6	2.2	.8	.3	1.6	.7	.7	.1	2.1	5.4	3.3
13	.5	2.8	4.1	3.2	1.0	.1	.8	.4	1.7	2.8	3.6	2.8
14	0	1.8	4.3	3.8	.9	0	1.8	1.4	2.0	1.8	3.5	2.3
15	.3	2.9	3.6	3.9	2.0	1.6	1.8	3.2	2.1	1.4	1.9	0
16	1.6	2.3	3.6	4.1	3.0	1.8	2.3	3.9	2.1	1.0	.6	.9
17	2.6	1.8	3.0	5.1	3.5	2.0	2.8	4.7	3.0	1	1.6	3.9
18	4.8	1.3	1.7	5.2	6.9	5.0	5.0	8.8	9.8	1.6	6.2	8.3
19	8.4	5.7	4.5	2.1	11.5	10.4	10.8	13.1	12.8	8.3	11.2	13.2
20	11.4	17.1	15.5	8.3	2.8	5.3	10.1	6.7	5.1	15.9	19.6	13.3
21	12.9	24.6	22.5	15.6	4.4	1.5	1.9	1.1	2.3	15.9	19.5	11.9
22	2.6	22.5	18.9	15.0	9.1	3.7	3.9	6.2	8.3	11.7	11.4	6.2
23	2.8	11.7	8.5	5.8	7.2	5.4	6.7	9.6	8.8	3.2	4.6	.4

TABLE VIII.

$\Delta'Y.$

UNIT $1\gamma.$

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon + 34 min.												
0	3.2	1.2	1.9	1.4	1.1	-7.0	-5.2	-13.0	-6	2.6	1.0	1.5
1	5.2	10.2	7.2	2.9	1.7	-2.1	-4.3	-3.5	.7	6.9	11.6	7.8
2	2.1	11.8	8.5	-1.9	1.2	1.0	-2.1	6.0	1.8	9.4	12.8	5.6
3	4.4	8.6	9.0	.4	4.7	1.7	.3	7.0	2.0	7.3	11.6	3.9
4	6.8	4.4	5.2	.3	-1.1	2.3	4.9	1.0	-1.7	5.8	4.2	3.8
5	3.4	1.6	2.9	-3.8	-2.9	.3	-3.0	-1.9	.5	-3.1	1.7	4.0
6	0	.1	1.0	-4.5	-3.3	.7	4.6	-6	3.6	-1.3	.7	3.4
7	.8	1.3	.7	-4.4	.1	-2.8	-8.2	-4.0	-3.4	.3	.9	.5
8	1.3	1.0	2.6	-3.1	2.2	-2.2	4.8	-7.4	-2.7	1.2	.2	2.0
9	1.5	2.0	-4.3	-3.0	-4.1	-1.6	-8.4	.7	-3.5	.5	2.5	1.8
10	8.7	2.4	-9	-1.9	-2.7	-1.3	5.3	.9	-3.2	1.3	2.6	2.3
11	2.3	2.5	1.5	.2	-1.6	.7	-2.4	2.5	.5	2.4	5.6	4.2
12	1.3	4.1	2.3	3.9	0	-1.7	.2	1.8	.2	2.0	4.6	2.7
13	.6	6.0	4.2	6.0	.8	.4	3.6	5.8	.8	2.6	4.3	1.2
14	.4	5.3	5.2	7.2	1.3	.7	5.4	4.7	1.4	2.1	3.1	1.3
15	-1.8	3.0	3.4	8.7	5.6	2.4	6.0	5.5	2.6	2.3	-2.3	-1.2
16	-1.9	1.8	3.0	7.6	5.6	1.3	4.0	5.3	1.7	2.2	.6	-1.6
17	-1.8	.7	2.3	9.5	4.5	1.7	4.6	7.3	3.4	.6	-1.9	-5.5
18	-3.0	-1.3	.5	7.8	6.6	5.5	3.9	8.9	6.8	-1.2	-3.7	-9.2
19	-4.8	.5	-4.6	5.1	7.7	11.1	10.2	15.3	11.1	-3.0	-11.8	-12.1
20	-8.6	-16.6	-13.9	-5.4	1.9	8.2	7.9	9.0	3.6	-6.6	-12.8	-8.5
21	-10.7	-23.0	-11.6	-9.1	4.0	.5	.6	.1	17.6	-14.2	-24.8	-6.7
22	-12.1	-12.8	-15.4	-5.1	6.4	-6.1	-3.2	-7.5	17.0	-10.1	-13.9	-2.2
23	-3.9	-4.0	-13.1	-1.4	-3.4	-8.2	-6.2	-15.4	12.3	-4.6	-7.0	1.0

TABLE IX.

$\Delta''Y.$

UNIT $1\gamma.$

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon + 34 min.												
0	5.1	1.3	4.5	3.0	-10.0	5.2	-1.9	28.1	13.9	15.5	2.0	.3
1	19.6	.9	9.9	9.4	-7.1	4.4	6.3	-2.4	.1	18.5	-13.9	13.0
2	31.9	10.8	14.5	21.4	-2.8	.3	17.2	-21.2	.3	12.8	-9.8	9.5
3	12.6	13.5	17.1	9.4	.4	1.1	10.2	-21.0	-2.4	8.4	-9.0	7.3
4	-5.4	14.9	5.2	10.1	6.9	.1	-19.3	1.6	1.6	5.5	-1.0	.2
5	5.8	11.4	.5	13.7	5.5	.7	6.2	-5.1	9.2	9.1	2.2	-7.1
6	-13.4	5.4	2.0	6.8	6.6	-4.2	7.1	-9.9	1.1	3.4	9.3	-6.9
7	5.9	3.4	.7	8.0	1.9	-4.5	17.6	.2	3.6	2.8	9.0	2.9
8	6.0	3.0	.6	4.1	6.1	-5.4	5.3	13.2	-1.9	.4	14.3	2.2
9	0	.7	-2.9	4.6	6.9	-8.5	11.0	-5.2	.2	6.6	7.7	4.2
10	-3.7	.8	5.7	2.8	4.1	-8.5	8.7	-16.4	1.5	1.7	6.0	4.5
11	4.9	-2.6	2.1	1.2	.8	-6.1	1.5	-20.7	-3.9	-1.7	.8	0
12	1.8	-2.5	.2	-7.2	.4	1.4	-5.3	-11.9	.5	.7	4.5	2.5
13	-1.1	-12.7	.6	-6.6	.3	.3	-13.5	-19.2	13.4	.2	.3	5.1
14	.7	-5.6	-4.0	-7.8	.9	-2.9	-20.0	-17.1	.7	-1.2	2.2	3.1
15	6.8	-1.4	.3	-9.6	-10.7	-4.3	-23.0	-14.5	-3.1	-3.1	4.7	4.3
16	5.2	.9	1.1	-8.3	-9.0	+6	-7.8	-10.1	3.6	-4.7	0	.3
17	3.1	2.9	2.8	-10.4	-2.9	+1.3	-9.9	-9.9	-2.3	-1.9	.4	5.1
18	-8.6	7.2	8.4	-6.0	.1	-2.0	6.3	-6	19.8	.8	-9.6	2.7
19	-14.6	-9.1	.1	-6.8	7.6	-3.1	1.7	-5.3	11.3	-19.3	-8.0	-3.8
20	-8.8	-1.8	-3.0	-6.5	3.6	1.9	11.9	+1.9	10.5	-26.7	-29.5	-16.8
21	-7.5	-4.0	-20.7	-15.3	-1.1	2.8	12.3	4.4	17.5	-5.9	15.0	-18.4
22	12.3	-34.8	-12.3	-22.3	-6.5	8.4	-2.2	5.3	-7.5	-4.7	9.5	-15.3
23	5.7	-32.9	-11.1	-13.5	-9.8	12.9	-5.8	25.0	-5.0	5.7	23.6	-2.9

TABLE X.

 $\Delta X.$ UNIT 1γ .

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon +34 min.												
0	2.2	.7	1.2	3.0	4.5	2.3	4.1	12.0	8.0	4.3	5.3	1.9
1	3.8	7.5	4.5	6.2	1.7	.4	1.4	3.1	1.9	5.6	5.8	5.2
2	5.3	10.1	6.9	5.4	3.5	1.7	1.2	2.8	1.8	4.3	5.6	6.5
3	3.2	8.6	4.8	4.7	2.2	.4	.5	5.0	3.7	2.8	4.6	4.5
4	1.9	6.1	1.9	3.5	.8	4.5	5.5	2.8	4.0	2.0	3.5	3.0
5	2.3	3.2	2.0	3.0	1.5	4.8	3.8	0	4.1	2.6	5.2	3.7
6	3.3	4.0	4.7	4.8	.3	2.4	1.3	2.1	6.5	5.1	6.4	4.6
7	6.0	7.0	6.6	6.0	.5	.1	.4	5.0	7.0	6.8	10.9	8.9
8	8.0	7.3	7.7	6.4	4.1	2.3	2.6	5.8	7.8	7.1	9.3	10.0
9	7.9	7.1	6.4	6.2	5.8	3.6	4.9	8.6	7.6	6.8	8.2	8.6
10	7.7	6.0	5.9	4.7	5.0	3.6	5.7	5.3	6.1	5.8	7.3	7.9
11	6.6	4.1	4.3	3.0	4.8	3.8	4.8	4.7	3.4	4.4	5.8	6.8
12	3.6	1.8	3.4	5.2	3.4	4.0	5.1	4.1	2.8	3.0	4.2	5.8
13	2.7	1.3	1.5	.2	3.2	4.3	4.1	3.4	1.9	2.2	3.6	4.8
14	1.3	.1	.7	.2	3.2	4.0	2.7	3.1	.6	1.4	1.8	3.2
15	.4	.2	1.0	1.3	3.5	3.5	3.1	3.5	1.1	.3	.9	2.5
16	1.6	.6	.2	.2	3.0	3.2	2.9	3.1	1.1	.2	1.2	.2
17	5.3	1.3	.4	.3	2.9	3.4	1.9	4.0	1.8	1.8	5.1	5.4
18	9.7	4.5	2.4	.9	2.0	2.9	1.2	5.3	5.2	5.9	13.3	13.2
19	13.9	12.2	11.3	7.2	.4	1.7	.8	2.4	.9	13.8	19.9	19.4
20	15.9	18.1	19.2	14.2	7.5	2.0	3.6	5.4	9.6	18.7	21.2	20.4
21	12.1	19.5	18.6	16.8	13.4	9.3	9.1	13.3	16.7	15.0	17.4	17.2
22	6.4	12.7	10.7	12.7	13.8	9.7	11.8	16.9	17.6	8.1	6.7	8.8
23	2.3	6.5	4.2	4.7	9.5	6.0	9.4	16.4	13.6	1.3	.9	2.5

TABLE XI.

 $\Delta'X.$ UNIT 1γ .

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon +34 min.												
0	1.4	5.5	5.5	10.8	2.7	.9	.8	3.2	6.5	2.6	2.3	2.9
1	2.2	10.3	6.0	11.9	1.0	3.5	.6	5.9	3.5	2.4	5.4	2.1
2	.6	8.4	4.5	3.8	.4	2.8	.8	3.7	.9	2.7	3.5	5.3
3	.8	6.1	4.6	3.3	6.6	2.0	.5	1.7	.6	1.5	5.5	3.3
4	.9	3.0	.3	3.4	1.5	4.3	1.3	2.3	5.3	3.6	8.1	1.0
5	6.5	1.6	.9	2.6	2.4	3.6	1.6	4.9	3.9	5.4	6.7	3.8
6	6.9	3.1	6.3	4.7	.1	2.5	1.1	3.1	6.4	4.6	7.3	3.8
7	5.3	6.1	5.3	5.7	2.4	1.2	1.5	3.1	7.6	5.5	9.9	8.1
8	6.7	6.2	4.7	5.3	5.9	1.8	4.5	3.0	8.8	4.6	9.2	10.6
9	7.2	5.5	17.1	4.9	6.9	2.9	6.2	4.0	7.8	7.6	8.9	9.9
10	1.6	4.9	7.2	5.1	7.3	3.0	8.3	6.6	8.3	6.4	7.4	8.6
11	4.6	3.6	5.3	2.2	4.8	3.4	5.2	3.7	3.4	3.7	4.8	6.3
12	3.1	2.0	3.5	1.3	4.4	4.4	3.6	6.7	4.8	3.6	3.3	5.6
13	1.4	2.0	.2	3.0	3.8	4.4	2.8	.2	5.5	2.1	1.9	4.1
14	.3	1.6	.1	4.0	4.2	4.2	.5	1.7	1.7	1.6	.8	2.2
15	1.4	1.3	.8	2.5	4.3	2.4	1.5	2.4	1.2	.4	1.7	2.0
16	.9	1.9	1.2	1.4	3.5	2.4	1.0	5.0	.7	.1	1.5	11.8
17	5.0	3.2	.3	1.2	2.9	2.8	2.6	5.3	1.5	2.5	3.9	4.1
18	4.9	6.5	6.3	5.8	0	2.6	2.9	6.3	3.1	5.3	11.9	10.5
19	9.8	10.1	10.9	8.1	1.9	.8	2.8	.7	.5	10.1	19.0	14.3
20	10.1	17.6	24.2	13.7	5.3	4.4	7.0	10.2	9.7	16.5	19.0	15.2
21	7.2	15.2	14.1	13.5	11.7	11.3	11.0	2.2	17.6	13.6	20.5	12.9
22	6.2	5.8	8.3	5.8	11.2	10.6	10.4	6.8	15.0	5.9	9.8	7.3
23	1.1	1.0	3.9	3.8	7.6	5.8	6.3	6.9	9.5	.9	6.8	1.5

TABLE XII.

$\Delta''X$.

UNIT 1γ .

Cape of Good Hope Hours (Astronomical).	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Noon +34 min.												
0	-4.2	22.2	15.3	18.4	1.7	11.4	18.0	32.9	9.3	-5.8	-2.7	16.9
1	-10.3	13.0	8.0	14.0	-4.1	17.4	7.0	6.3	-11.4	-11.6	-1.2	-12.9
2	-20.0	-5.0	-4.5	-4.7	-13.8	4.8	-3.0	3.8	-18.5	-5.1	3.3	-3.8
3	-20.7	-5.6	1.9	-5.6	-12.7	7.9	-3.8	-13.8	-28.2	-4.7	4.4	-4.5
4	-5.5	-7.7	5.2	-4.3	-10.2	-2.5	22.4	-4.1	-19.0	-3.0	.8	-5.5
5	5.5	-4.9	-5.1	-1.1	-2.0	6.0	11.8	-4.0	-1.1	0	5.2	1.0
6	-1.7	-2.3	7.4	.2	.4	-1.0	13.2	4.6	-1.3	-1.5	3.9	-2.3
7	-3.2	-2.7	.4	.9	-2.1	-7.0	6.7	-6.4	4.9	-4.7	2.9	-2.6
8	-5.7	-3.9	2.8	-2.3	2.8	-4.8	11.4	-1.5	5.7	-9.0	.4	1.0
9	-3.3	-7.0	-2.3	-3.0	5.5	-5.3	8.4	-11.2	.7	3.8	2.4	4.7
10	3.3	-4.5	6.8	1.3	8.1	-5.3	14.3	7.2	18.1	2.0	1.2	2.4
11	6.1	-3.6	3.9	-2.0	.4	-4.2	.5	-2.3	-2	-2.3	2.7	.9
12	-2.1	.4	1.4	-7.1	3.5	3.0	-8.6	10.2	12.9	1.8	-2.4	.4
13	-6.2	-16.2	-1.6	-7.8	2.8	2.1	-7.8	-3.6	2.7	0	-5.8	-2.4
14	-8.7	6.7	-3.8	-9.9	3.4	.2	-11.8	-3.9	5.9	.9	-3.7	-3.4
15	-5.3	-5.3	-7.2	-3.5	3.6	-5.6	-8.7	-1.4	1.0	-2.9	6.2	-2.2
16	8.1	-4.5	-5.5	-3.8	2.0	-3.8	-16.7	8.6	-2.8	-9	.6	-5.7
17	1.2	-8.0	.5	-3.1	.7	1.0	-25.5	4.6	-2.7	-2.9	4.7	5.3
18	8.2	-10.8	-12.0	-10.6	-7.2	-1.5	-21.9	4.9	-13.3	.5	5.6	9.4
19	23.2	-1.0	-12.0	-1.9	-4.2	-3.7	-18.9	-13.2	-8.7	13.1	9.5	17.7
20	28.2	1.0	-22.2	.7	8.1	-1.1	-18.1	-20.6	-3.9	4.0	15.0	20.0
21	23.7	3.9	15.5	4.7	5.5	-8.0	-10.6	43.5	-7.0	4.6	-9.4	15.0
22	1.3	25.4	8.2	14.9	7.8	-1.6	1.2	37.1	25.9	7.5	-10.6	5.4
23	7.9	13.3	13.8	19.9	4.5	11.4	10.8	37.7	27.6	7.8	3.9	-9.9

§ 5. Discussion of Results.

At the outset it is well to observe that the period over which the observations extend is unavoidably limited. In dealing with sun-spot effect it is advisable to consider at least one eleven-year period, so that it is difficult to say whether the various results I have obtained are truly representative of the average conditions for a whole sun-spot period; however, as far as comparison with other results of a similar nature is possible, they do not appear to be exceptional.

An examination of the tables shows that there is a marked resemblance between the variation of the daily inequality Δ and Δ' . This resemblance is noticeable in all the elements considered. On the other hand Δ'' shows very great irregularity. This may possibly be in part due to the shortness of the period under consideration. Chree, in Phil. Trans. of the Royal Society of London, points out that there are two maxima and minima in the daily inequality of the

declination at Falmouth and Kew. Schmidt's results (Archiv. des Erdmagnetismus Heft I.) show that there are two maxima and minima in the values of ΔD for a period corresponding to that with which we are dealing at Toronto, Hobarton, and St. Helena. In this respect the Cape is no exception, as similar maxima and minima are readily observed in the case of the Declination results. The figures for the Horizontal Intensity, obtained from the same sources, also show agreement.

Consider the value of the ratio $\frac{b}{a}$ for each month, where b is the arithmetic mean of the quantities Δ'' for the month, and a is the arithmetic mean of Δ' for the same month. For purposes of comparison I have calculated from Schmidt (Archiv. des Erd. Heft I.) the value of the ratio for Declination and Horizontal Intensity for stations, Hobarton, Toronto, and St. Helena, and have collected corresponding results from Chree (Phil. Trans. [A], vol. 203). The

	Cape.		Hobarton.		Toronto.		St. Helena.		Katharinen- burg.		Pawlowsh.		Batavia.		Mauritius.	
	D.	H.	D.	H.	D.	H.	D.	H.	D.	H.	D.	H.	D.	H.	D.	H.
I.	1.89	2.78	.43	.6	.69	.6	1.47	.9	.20	1.30	1.30	1.04	.60	.78	.63	.26
II.	1.29	1.70	.58	.8	1.18	2.0	1.28	.9	.95	1.17	2.09	1.65	.45	.85	.25	.55
III. ....	.79	1.85	.52	.6	.59	1.2	.59	.7	1.10	1.12	1.20	1.62	.78	1.06	.23	.67
IV.	1.98	1.09	.85	1.4	.22	1.2	.60	1.1	.53	1.26	.51	.83	.55	.55	.55	.35
V. ....	.84	1.16	.86	1.5	.38	1.6	1.19	.5	.53	.58	.68	.97	.71	.77	.86	.55
VI. ....	.9	1.82	.77	1.1	.23	.9	.61	.5	.60	.95	.48	.67	.46	.82	.35	.78
VII.	2.24	2.77	.85	1.3	.51	1.8	2.09	3.0	.48	1.13	.54	.80	.74	.80	.80	.56
VIII. ...	1.63	5.17	.60	1.0	.37	.6	.29	.4	.34	.72	.40	.40	.57	.74	.69	.75
IX.	2.29	1.72	.48	.7	.24	.5	1.21	.4	.54	.85	.50	.58	.77	.73	.26	.69
X.	1.26	1.09	.45	.5	.54	1.1	.65	.8	.71	1.47	.62	.97	.41	.84	.23	.70
XI. ....	.88	.95	.41	.8	.64	.9	.47	1.1	.88	2.39	1.07	2.10	.40	1.01	.52	1.29
XII. ....	.79	1.0	.46	1.9	.73	1.7	1.31	.3	.42	.50	1.09	3.08	.52	.70	.18	.76

latter, however, do not lend themselves so well to purposes of comparison with Cape results, as they refer to a period which does not correspond to that with which we are dealing. In the case of Declination at the Cape and St. Helena agreement is very conspicuous. For nearly the whole mean year $\frac{b}{a}$ increases or decreases together at the two stations.

The seasonal values of the ratio show excellent agreement for the stations under consideration. We see from the figures that the maximum value occurs in winter. In the case of the Declination

the only exception is Katharinenburg, where it is a maximum in the Equinox. Batavia and Mauritius are exceptions as far as the value of the ratio for Horizontal force is concerned. There may possibly be some explanation of these three cases other than that

	Cape.		Hobarton.		Toronto.		St. Helena.	
	D.	H.	D.	H.	D.	H.	D.	H.
Summer	1·14	1·4	·47	·9	·37	1·2	1·06	·8
Winter	1·53	2·5	·68	1·2	1·00	1·3	1·32	1·0
Equinox	1·42	1·4	·56	·7	·37	·9	·68	·7

	Katharinenburg.		Pawlowsh.		Batavia.		Mauritius.	
	D.	H.	D.	H.	D.	H.	D.	H.
Summer	·49	·83	·52	·71	·49	·83	·39	·71
Winter	·61	1·30	1·39	1·83	·62	·78	·68	·66
Equinox	·68	1·15	·68	·94	·61	·78	·30	·60

the maximum sun-spot influence occurs at different seasons at these stations.

In conclusion, I wish to record my thanks to Prof. Beattie for his many valuable suggestions and kind encouragement while this investigation was in progress.